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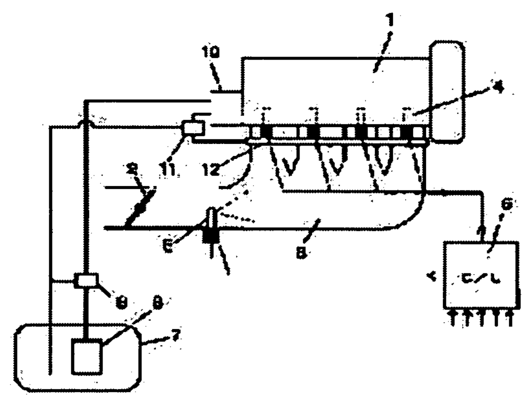
(54) FUEL INJECTION CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To prevent an air fuel ratio error at the time of switching by providing a means for temporarily correcting a fuel injection amount of a main fuel injection valve to be increased at the time of switching an auxiliary fuel injection valve to the operating condition, and a means for temporarily correcting the fuel injection amount of the main fuel injection valve to be decreased at the time of switching the auxiliary fuel injection valve to the non-operating condition.



SOLUTION: During the operation of an internal combustion engine 1, in a control unit 6, according to the engine operating condition, the fuel injection amount per one cylinder is computed. Further, it is determined whether an auxiliary fuel injection valve 5 is in the operating region or not, and in the case of the operating region, the sharing rate of the main fuel injection valve 4 and the auxiliary fuel injection valve 5 is set. Further, the required fuel injection amount is multiplied by the sharing rate of the main fuel injection valve 4, and multiplied by a previously computed designated correction rate to compute the fuel injection amount of the main fuel injection amount. After that, each fuel injection amount is converted to an injection pulse duration in consideration of fuel pressure to be set on a designated register.

LEGAL STATUS

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CLAIMS

[Claim(s)]
[Claim 1] Are the direct injection jump-spark-ignition type internal combustion engine which equips a combustion chamber with the main-fuel injection valve which injects a direct fuel, and apart from said main-fuel injection valve, while preparing the auxiliary fuel injection valve which can inject a fuel in an inhalation-of-air path In what established the change-over control means which operates an auxiliary fuel injection valve in a predetermined service condition, and makes the fuel supply to an engine share with a main-fuel injection valve and an auxiliary fuel injection valve The increase-in-quantity amendment means which carries out increase-in-quantity amendment of the fuel oil consumption of said main-fuel injection valve temporarily at the time of the change-over to the operating state of said auxiliary fuel injection valve from a non-operating state, The fuel-injection control unit of the internal combustion engine characterized by establishing the loss-in-quantity amendment means which carries out loss-in-quantity amendment of the fuel oil consumption of said main-fuel injection valve temporarily at the time of the change-over to the non-operating state of said auxiliary fuel injection valve from an operating state.
[Claim 2] Said increase-in-quantity amendment means is the fuel-injection control unit of the internal combustion engine according to claim 1 characterized by setting up an increase-in-quantity correction factor according to an engine load at least.
[Claim 3] Said increase-in-quantity amendment means is the fuel-injection control unit of the internal combustion engine according to claim 1 characterized by setting up an increase-in-quantity correction factor according to the wall temperature of an inhalation-of-air path at least.
[Claim 4] Said loss-in-quantity amendment means is the fuel-injection control unit of the internal combustion engine of any one publication of claim 1 characterized by setting up a loss-in-quantity correction factor according to an engine load at least - claim 3.
[Claim 5] Said loss-in-quantity amendment means is the fuel-injection control unit of the internal combustion engine of any one publication of claim 1 characterized by setting up a loss-in-quantity correction factor according to the wall temperature of an inhalation-of-air path at least - claim 3.
[Claim 6] Said loss-in-quantity amendment means is the fuel-injection control unit of the internal combustion engine of any one publication of claim 1 characterized by setting up a loss-in-quantity correction factor according to the duration of the operating state of the last auxiliary fuel injection valve at least - claim 3.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] In the direct injection jump-spark-ignition type internal combustion engine which equips a combustion chamber with the main-fuel injection valve which injects a direct fuel, apart from said main-fuel injection valve, this invention prepares the auxiliary fuel injection valve which can inject a fuel in an inhalation-of-air path, operates an auxiliary fuel injection valve in a predetermined service condition, and relates to the fuel-injection control unit in the case of making the fuel supply to an engine share with a main-fuel injection valve and an auxiliary fuel injection valve.
[0002]
[Description of the Prior Art] The direct injection jump-spark-ignition type internal combustion engine attracts attention in recent years. In this thing According to an engine service condition, a combustion system by injecting a fuel like change-over control, i.e., an inhalation-of-air line It is common to carry out change-over control to the homogeneity combustion performed by making a combustion chamber diffuse a fuel and forming the gaseous mixture of homogeneity, and the stratification combustion performed to the circumference of an ignition plug by forming layer-like gaseous mixture intensively by injecting a fuel in a compression stroke (refer to JP,59-37236,A).
[0003]
[Problem(s) to be Solved by the Invention] By the way, in such a direct injection jump-spark-ignition type internal combustion engine, apart from the main-fuel injection valve which injects a direct fuel to a combustion chamber, the auxiliary fuel injection valve which can inject a fuel is prepared in an inhalation-of-air path, an auxiliary fuel injection valve is operated in a predetermined service condition (at the time [At least] of homogeneity combustion), and it considers making the fuel supply to an engine share with a main-fuel injection valve and an auxiliary fuel injection valve.
[0004] This aims at the following effectiveness.
(1) An improvement of combustion by the dissolution (2) homogeneity inhalation of air of the fuel-oil-consumption insufficient field represented by high rotation and the heavy load (in high rotation and a heavy load field, since the time amount (evaporation time amount) from the injection in a cylinder to ignition becomes short, the fuel beforehand homogenized in the inhalation-of-air path (homogeneity gaseous mixture-izing) is supplied, and homogenization in a cylinder is attained)
(3) Improvement in the volumetric efficiency by inhalation-of-air cooling (latent heat of vaporization is taken in an inhalation-of-air path, and inhalation effectiveness is raised).
[0005] However, by such method, at the time of the change-over to the operating state of an auxiliary fuel injection valve from a non-operating state (at the time of OFF->ON), since some fuels injected from the auxiliary fuel injection valve adhere to an inhalation-of-air path wall and it serves as a wall style, the RIN error of an air-fuel ratio is temporarily produced by the transportation lag of the fuel by the wall style. Moreover, at the time of the change-over to the non-operating state of an auxiliary fuel injection valve from an operating state (at the time of ON->OFF), since a part for a wall style is inhaled, a fuel becomes superfluous and the rich error of an air-fuel ratio is produced temporarily.
[0006] This invention takes an example by such trouble, and aims at preventing the air-fuel ratio error at the time of change-over of actuation and not operating. [of an auxiliary fuel injection valve]

[0007]
[Means for Solving the Problem] For this reason, he is the direct injection jump-spark-ignition type internal combustion engine which equips a combustion chamber with the main-fuel injection valve which injects a direct fuel in this invention (claim 1) as shown in drawing 1 . Apart from said main-fuel injection valve, while preparing the auxiliary fuel injection valve which can inject a fuel in an inhalation-of-air path In what established the change-over control means which operates an auxiliary fuel injection valve in a predetermined service condition, and makes the fuel supply to an engine share with a main-fuel injection valve and an auxiliary fuel injection valve The increase-in-quantity amendment means which carries out increase-in-quantity amendment of the fuel oil consumption of said main-fuel injection valve temporarily at the time of the change-over to the operating state of said auxiliary fuel injection valve from a non-operating state, At the time of the change-over to the non-operating state of said auxiliary fuel injection valve from an operating state, the loss-in-quantity amendment means which carries out loss-in-quantity amendment of the fuel oil consumption of said main-fuel injection valve temporarily is established, and an internal combustion engine's fuel-injection control unit is constituted.
[0008] In this case, said increase-in-quantity amendment means is good to set up an increase-in-quantity correction factor according to the wall temperature (claim 3) of an engine load (claim 2) and an inhalation-of-air path. In addition, that what is necessary is just to detect an inhalation air content etc. as an engine load, direct detection of this may not be carried out about the wall temperature of an inhalation-of-air path, but you may substitute with an intake-air temperature or water temperature. Moreover, said loss-in-quantity amendment means is good to set up a loss-in-quantity correction factor according to the duration (claim 6) of the operating state of the wall temperature (claim 5) of an engine load (claim 4) and an inhalation-of-air path, and the last auxiliary fuel injection valve.
[0009]
[Effect of the Invention] According to this invention (claim 1), the RIN error of the air-fuel ratio by wall style adhesion can be prevented by carrying out increase-in-quantity amendment of the fuel oil consumption of a main-fuel injection valve temporarily at the time of the change-over to the operating state of an auxiliary fuel injection valve from a non-operating state (at the time of OFF->ON). Moreover, the rich error of the air-fuel ratio by wall style inhalation can be prevented by carrying out loss-in-quantity amendment of the fuel oil consumption of a main-fuel injection valve temporarily at the time of the change-over to the non-operating state of an auxiliary fuel injection valve from an operating state (at the time of ON->OFF).
[0010] Moreover, since a wall flow rate changes and a wall flow rate serves as size by the heavy load side with an engine load, an increase-in-quantity correction factor and a reduction correction factor are set up according to an engine load, and it can respond to these good because a heavy load side enlarges an increase-in-quantity correction factor and a reduction correction factor (claim 2, claim 4). Moreover, since a wall flow rate changes and a wall flow rate serves as size by the low temperature side by the wall temperature of an inhalation-of-air path, an increase-in-quantity correction factor and a reduction correction factor are set up according to the wall temperature of an inhalation-of-air path, and it can respond to these good because low temperature enlarges an increase-in-quantity correction factor and a reduction correction factor (claim 3, claim 5).
[0011] Furthermore, a wall flow rate changes by the duration (ON region residence time) of the operating state of an auxiliary fuel injection valve, and it can respond to this good by setting up the reduction correction factor at the time of ON->OFF according to this time amount, since a wall flow rate will serve as size, if this time amount is long, and enlarging a reduction correction factor, so that this time amount is long (claim 6).
[0012]
[Embodiment of the Invention] The gestalt of operation of this invention is explained below. Drawing 2 is the system chart of the internal combustion engine which shows 1 operation gestalt. First, this is explained. In the combustion chamber of each gas column of the internal combustion engine 1 carried in a car, air is inhaled from the inhalation-of-air path (inlet manifold) 3 in response to control of a throttle valve 2.
[0013] And for every gas column, the electromagnetic main-fuel injection valve 4 is formed so that a

fuel (gasoline) may be injected directly into a combustion chamber. Moreover, the electromagnetic auxiliary fuel injection valve 5 is formed so that a fuel may be injected in the set section (collector) of an inlet manifold 3 and it may distribute to each gas column [all / gas column]. In addition, in the case of a 4-cylinder, this auxiliary fuel injection valve 5 is also called the 5th valve.
[0014] The main-fuel injection valve 4 is energized to a solenoid by the injection pulse signal to which the inhalation-of-air line of each gas column is outputted in a compression stroke from a control unit 6 synchronizing with engine rotation, opens, and injects the fuel whose pressure was regulated by the predetermined high-pressure force. And in compression stroke injection, in injection of an inhalation-of-air line, the injected fuel is spread in a combustion chamber, and homogeneous gaseous mixture is formed, and layer-like gaseous mixture is intensively formed in the circumference of an ignition plug, and it is lit by the ignition plug and burns (homogeneity combustion or stratification combustion).
[0015] The auxiliary fuel injection valve 5 is energized to a solenoid by the injection pulse signal which is a specific region at the time of homogeneity combustion, or is outputted for every rotation from a control unit 6 synchronizing with engine rotation synchronizing with a change with stratification combustion and homogeneity combustion at the time of homogeneity combustion, opens, and injects the fuel whose pressure was regulated by the predetermined low voltage force. And it homogenizes to some extent within an inlet manifold 3, and the injected fuel is distributed to each gas column.
[0016] In addition, the fuel-supply system to the main-fuel injection valve 4 and the auxiliary fuel injection valve 5 The low voltage fuel pump 8 which carries out the inhalation regurgitation of the fuel in a fuel tank 7, and the low voltage regulator 9 which regulates the pressure of the discharge-side pressure of the low voltage fuel pump 8, The high-pressure fuel pump 10 which pressurizes further the fuel from the low voltage fuel pump 8, It is constituted including the high-pressure regulator 11 which regulates the pressure of the discharge-side pressure of a high-pressure fuel pump. The high-pressure fuel whose pressure was regulated by the high-pressure regulator 11 is supplied to the main-fuel injection valve 4 through the fuel gallery 12, and the low voltage fuel whose pressure was regulated by the low voltage regulator 9 is supplied to the auxiliary fuel injection valve 5.
[0017] A control unit 6 is equipped with the microcomputer constituted including CPU, ROM, RAM, an A/D converter, an input/output interface, etc., receives the input signal from various sensors, it carries out data processing based on this, and it controls actuation of the main-fuel injection valve 4, the auxiliary fuel injection valve 5, etc. Although illustration was omitted about said various sensors, an engine's 1 crankshaft or cam shaft rotation is detected, and the crank angle sensor which can detect the engine rotational frequency NE by this, the air flow meter which detects the inhalation air content QA in the throttle-valve 2 upstream, the throttle sensor which detects the opening TVO of a throttle valve 2, the coolant temperature sensor which detects an engine's 1 cooling water temperature TW, the intake temperature sensor which detects an intake-air temperature TA are formed.
[0018] Next, the flow chart of drawing 3 - drawing 5 explains the fuel-injection control performed by the control unit 6. Drawing 3 is a fuel-injection control routine, and is performed for every predetermined rotation and every predetermined time. This routine is equivalent to a change-over control means. Step 1 (it is described in drawing as S1.) Based on an engine service condition at it being the same as that of the following, the fuel oil consumption QF of per a 1 cylinder (1 combustion) which an engine needs is calculated. The demand fuel oil consumption QF is calculated so that it may be set as homogeneity combustion or stratification combustion and may specifically become a target air-fuel ratio (he is [in homogeneity combustion] generally Lean in SUTOIKI and stratification combustion) from an engine service condition based on the inhalation air content QA and the engine rotational frequency NE.
[0019] At step 2, it judges whether it is the actuation region (ON region) of an auxiliary fuel injection valve. Here, let ON region of an auxiliary fuel injection valve be a specific region at the time of homogeneity combustion (high rotation and heavy load region). In the case of ON region of an auxiliary fuel injection valve, it progresses to step 3. At step 3, the rate P of an assignment of a main-fuel injection valve and an auxiliary fuel injection valve (rate of an assignment by the side of

an auxiliary fuel injection valve) is set up. This rate P of an assignment of considering as adjustable with an engine load is good.
[0020] At step 4, the demand fuel oil consumption QF is multiplied by the rate P of an assignment by the degree type, and it is the fuel oil consumption QF5 of an auxiliary fuel injection valve. It calculates.
It has doubled QF5 =2xQFxP2 because the auxiliary fuel injection valve is considered as a setup injection(2 cylinder every [i.e.,])-injected once to one rotation.
[0021] Fuel oil consumption QF5 of the auxiliary fuel injection valve calculated at step 5 It changes into injection pulse width (injection time) in consideration of fuel pressure (setting pressure of a low voltage regulator), and sets to a predetermined register. Thereby, if it becomes predetermined injection timing, an auxiliary fuel injection valve will drive by the signal of this injection pulse width, and fuel injection will be made in an inlet manifold.
[0022] At step 6, a correction factor (increase-in-quantity correction factor) HOS is calculated according to the subroutine of drawing 4 . About this, it mentions later. At step 7, the demand fuel oil consumption QF is multiplied by the rate of an assignment by the side of a main-fuel injection valve (1-P), and it multiplies by the correction factor HOS by the degree type, and is the fuel oil consumption QF 1-4 of a main-fuel injection valve. It calculates.
[0023] It progresses to QF1-4 =QFx(1-P) xHOS and step 10. Fuel oil consumption QF 1-4 of the main-fuel injection valve calculated at step 10 It changes into injection pulse width (injection time) in consideration of fuel pressure (setting pressure of a high-pressure regulator), and sets to a predetermined register. Thereby, if it becomes predetermined injection timing, a main-fuel injection valve will drive by the signal of this injection pulse width, and direct fuel injection will be made by the combustion chamber.
[0024] In the case of the OFF region of an auxiliary fuel injection valve, it progresses to step 8. In this case, fuel injection is performed only by the main-fuel injection valve. At step 8, a correction factor (loss-in-quantity correction factor) HOS is calculated according to the subroutine of drawing 5 . About this, it mentions later. At step 9, the demand fuel oil consumption QF is multiplied by the correction factor HOS by the degree type, and it is the fuel oil consumption QF 1-4 of a main-fuel injection valve. It calculates.
[0025] It progresses to QF1-4 =QFxHOS and step 10. Fuel oil consumption QF 1-4 of the main-fuel injection valve calculated as mentioned above at step 10 It changes into injection pulse width in consideration of fuel pressure, and sets to a predetermined register. Thereby, if it becomes predetermined injection timing, a main-fuel injection valve will drive by the signal of this injection pulse width, and direct fuel injection will be made by the combustion chamber.
[0026] The correction-factor (increase-in-quantity correction factor) arithmetic subroutine of drawing 4 is explained. This subroutine is equivalent to an increase-in-quantity amendment means. At step 41, it judges whether it is the first time of OFF->ON of an auxiliary fuel injection valve. In the case of the first time, it progresses to step 42, it sets up a correction factor (increase-in-quantity correction factor) HOS according to an engine load (inhalation air content QA) and an intake-air temperature TA (HOS> 1.0), and ends this subroutine. Here, a correction factor (increase-in-quantity correction factor) HOS is greatly set up, so that an intake-air temperature is so low that an engine load is large.
[0027] It progresses to step 43 after the first time, and it dwindles a correction factor (increase-in-quantity correction factor) HOS (minute value predetermined in HOS=HOS-delta HOS;delta HOS). And at step 44, it judges whether it became smaller than 1.0, and in the case of HOS<1.0, a correction factor (increase-in-quantity correction factor) HOS is step 45, and regulates to HOS=1.0.
[0028] By such control, as shown in drawing 6 , in case an auxiliary fuel injection valve decreases the fuel oil consumption of a main-fuel injection valve by assignment at the time of OFF->ON of an auxiliary fuel injection valve, temporarily the fuel oil consumption of a main-fuel injection valve by carrying out increase-in-quantity amendment Even if some fuels injected from the auxiliary fuel injection valve adhere to an inhalation-of-air path wall, it serves as a wall style and produces the transportation lag of a fuel, the RIN error of an air-fuel ratio can be prevented by increase-in-quantity amendment of the fuel oil consumption of a main-fuel injection valve.
[0029] The correction-factor (loss-in-quantity correction factor) arithmetic subroutine of drawing 5

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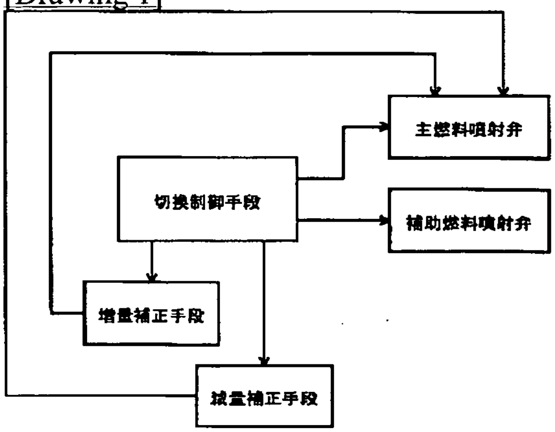
is explained. This subroutine is equivalent to a loss-in-quantity amendment means. At step 51, it judges whether it is the first time of ON->OFF of an auxiliary fuel injection valve. In the case of the first time, it progresses to step 52, it sets up a correction factor (loss-in-quantity correction factor) HOS according to an engine load (inhalation air content QA), an intake-air temperature TA, and ON region residence time (HOS<1.0), and ends this subroutine. Here, a correction factor (loss-in-quantity correction factor) HOS is set up greatly (more smaller than 1.0), so that ON region residence time is so still longer that an intake-air temperature is so low that an engine load is large.
[0030] It progresses to step 53 after the first time, and it increases gradually a correction factor (loss-in-quantity correction factor) HOS (minute value predetermined in HOS=HOS+delta HOS;delta HOS). And at step 54, it judges whether it became larger than 1.0, and in the case of HOS>1.0, a correction factor (loss-in-quantity correction factor) HOS is step 55, and regulates to HOS=1.0.
[0031] By carrying out loss-in-quantity amendment of the fuel oil consumption of a main-fuel injection valve temporarily by such control, at the time of OFF->ON of an auxiliary fuel injection valve, in case an auxiliary fuel injection valve increases the fuel oil consumption of a main-fuel injection valve by assignment, as shown in drawing 6 , even if a part for a wall style is inhaled, the rich error of an air-fuel ratio can be prevented by loss-in-quantity amendment of the fuel oil consumption of a main-fuel injection valve.
[0032] In addition, although it is larger than the fuel oil consumption before the fuel oil consumption of a main-fuel injection valve switching (at the time of OFF) by increase-in-quantity amendment of the first time at the time of OFF->ON and smaller than the fuel oil consumption before the fuel oil consumption of a main-fuel injection valve switching (at the time of ON) in drawing 6 by loss-in-quantity amendment of the first time at the time of ON->OFF, it does not restrict to this and increase-in-quantity amendment or loss-in-quantity amendment should just be made to the target fuel oil consumption after a change-over.
[0033] Next, other operation gestalten of this invention are explained. Synchronizing with a change with homogeneity combustion (homogeneity SUTOIKI combustion) and stratification combustion (stratification Lean combustion), this operation gestalt operates an auxiliary fuel injection valve at the time of homogeneity combustion, and when making the fuel supply to an engine share with a main-fuel injection valve and an auxiliary fuel injection valve, it is applied.
[0034] Drawing 7 is a fuel-injection control routine, and is performed for every predetermined rotation and every predetermined time. At step 11, homogeneity combustion or stratification combustion is judged based on an engine service condition. In homogeneity combustion, it progresses to step 12.
[0035] At step 12, the fuel oil consumption QFH of per a 1 cylinder (1 combustion) which the engine in homogeneity combustion needs is calculated. Based on the inhalation air content QA and the engine rotational frequency NE, specifically, the demand fuel oil consumption QFH is calculated so that it may become a target air-fuel ratio (generally SUTOIKI). and -- since it is ON region of an auxiliary fuel injection valve in homogeneity combustion -- after step 12 and step 13- 17 and 21 -- it is -- step 3- of drawing 3 -- it controls like 7 and 10. A different point is the operation expression of step 14 and step 17, and is a point of replacing with QF and using QFH as demand fuel oil consumption.
[0036] In stratification combustion, it progresses to step 18. At step 18, the fuel oil consumption QFS of per a 1 cylinder (1 combustion) which the engine in stratification combustion needs is calculated. Based on the inhalation air content QA and the engine rotational frequency NE, specifically, the demand fuel oil consumption QFS is calculated so that it may become a target air-fuel ratio (Lean).
[0037] And since it is the OFF region of an auxiliary fuel injection valve, in stratification combustion, it is steps 19-21 after step 18, and it is controlled like steps 8-10 of drawing 3 . A different point is the operation expression of step 20, and is a point of replacing with QF and using QFS as demand fuel oil consumption. Of course, at step 16 and step 19, the operation of a correction factor (an increase-in-quantity correction factor and loss-in-quantity correction factor) HOS is performed according to the subroutine of drawing 4 and drawing 5 .
[0038] By such control, as shown in drawing 8 at the time of the change-over to stratification combustion -> homogeneity combustion (at the time of OFF->ON of an auxiliary fuel injection

valve) In case an auxiliary fuel injection valve decreases the fuel oil consumption of a main-fuel injection valve by assignment and coincidence is increased for the formation of Lean -> SUTOIKI, temporarily the fuel oil consumption of a main-fuel injection valve by carrying out increase-in-quantity amendment Even if some fuels injected from the auxiliary fuel injection valve adhere to an inhalation-of-air path wall, it serves as a wall style and produces the transportation lag of a fuel, the RIN error of an air-fuel ratio can be prevented by increase-in-quantity amendment of the fuel oil consumption of a main-fuel injection valve.
[0039] Moreover, by carrying out loss-in-quantity amendment of the fuel oil consumption of a main-fuel injection valve temporarily, as shown in drawing 8 , in case an auxiliary fuel injection valve increases the fuel oil consumption of a main-fuel injection valve by assignment and coincidence is decreased for the formation of SUTOIKI -> Lean at the time of the change-over to homogeneity combustion -> stratification combustion (at the time of OFF->ON of an auxiliary fuel injection valve), even if a part for a wall style is inhaled, the rich error of an air-fuel ratio can be prevented by loss-in-quantity amendment of the fuel oil consumption of a main-fuel injection valve.

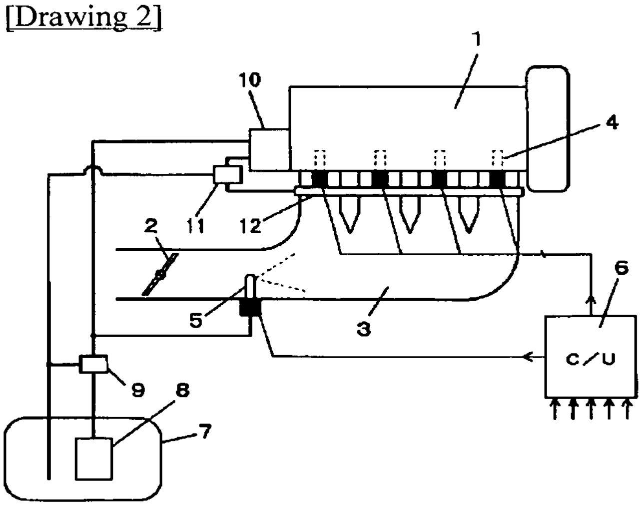
[Translation done.]

DRAWINGS

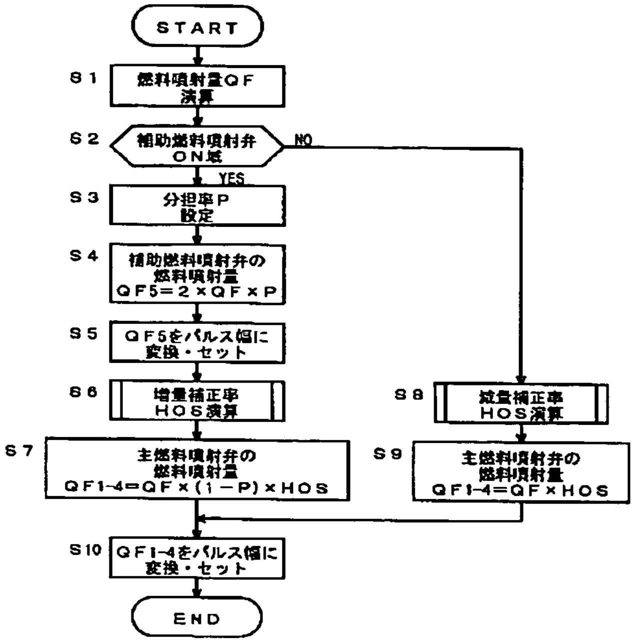
[Drawing 1]



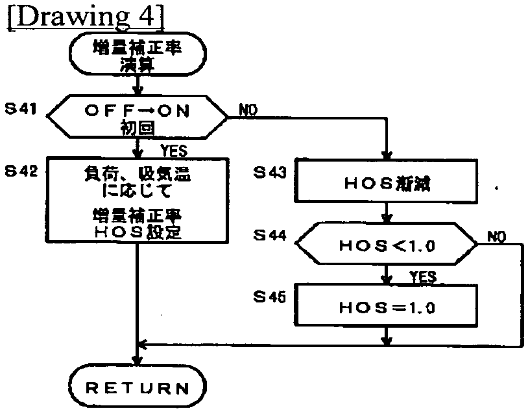
[Drawing 2]



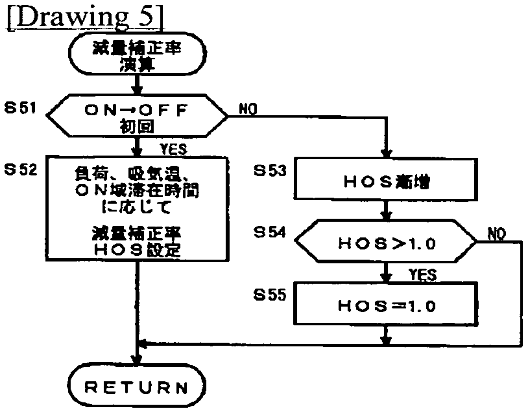
[Drawing 3]



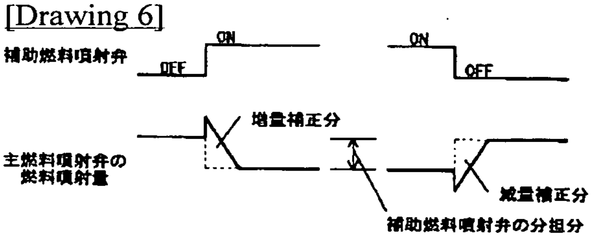
[Drawing 4]



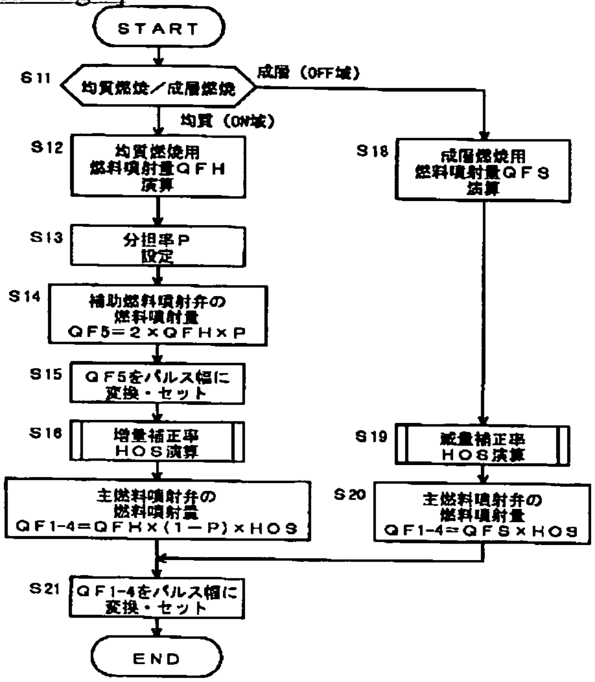
[Drawing 5]



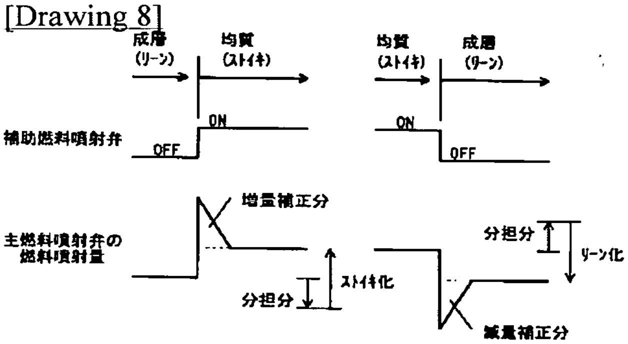
[Drawing 6]



[Drawing 7]



[Drawing 8]



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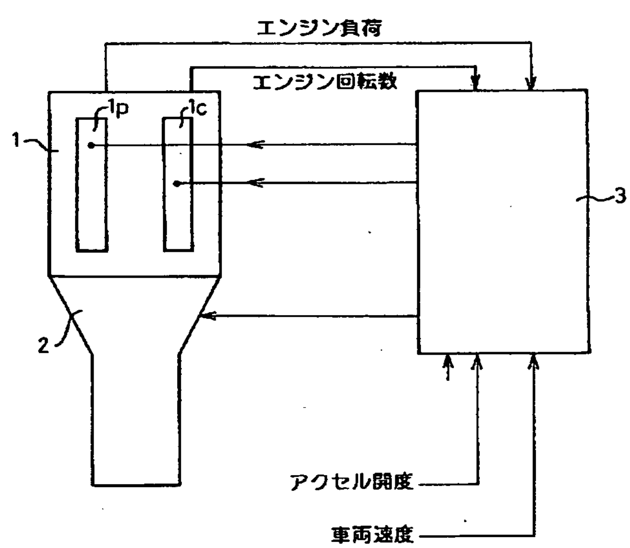
(54)【発明の名称】自動車用エンジンの燃料噴射装置

(57)【要約】
【目的】　高い精度の燃料制御性を必要とせずに筒内噴射とポート噴射の切り換え時のショックを車両の乗員に伝えない、あるいはショックの伝達を軽減する様にした燃料噴射装置を提供すること。
【構成】　ポート噴射と筒内噴射とを切り換える噴射方法切り換え手段を有し、運転状態に応じてポート噴射と筒内噴射とを切り換えるロックアップ付き自動変速機と一緒に用いられる自動車用エンジンの燃料噴射装置において、ロックアップ作動検出手段を設け、ロックアップ作動中はポート噴射と筒内噴射との切り換えを禁止するか、または、ロックアップ作動領域よりも高負荷側で切り換えを行う。あるいは、手動変速機の場合を含めフューエルカット状態を検出する手段を備え、フューエルカット時にポート噴射から筒内噴射に切り換える。



1p…ポート噴射弁
1c…筒内噴射弁

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【特許請求の範囲】

【請求項１】　運転状態の変化に応じてポート噴射と筒内噴射とを切り換える噴射方法切り換え手段を有したロックアップ付き自動変速機と一緒に用いられる自動車用エンジンの燃料噴射装置において、

運転状態が予め定めておいたポート噴射の領域と筒内噴射の領域の境界線を越えて変化したかどうかを判定する運転状態判定手段と、ロックアップ付き自動変速機のロックアップ作動検出手段とを備え、

運転状態が予め定めておいたポート噴射の領域と筒内噴射の領域の境界線を越えて変化し、前記ロックアップ作動検出手段がロックアップ作動信号を出力していない場合にのみポート噴射と筒内噴射との切り換えを行う様にしたことを特徴とするエンジンの燃料噴射装置。

【請求項２】　運転状態の変化に応じてポート噴射と筒内噴射とを切り換える噴射方法切り換え手段を有したロックアップ付き自動変速機と一緒に用いられる自動車用エンジンの燃料噴射装置であって、

運転状態が予め定めておいたポート噴射の領域と筒内噴射の領域の境界線を越えて変化したかどうかを判定する運転状態判定手段を備え、

運転状態が予め定めておいたポート噴射の領域と筒内噴射の領域の境界線を越えて変化した場合にはポート噴射と筒内噴射とを切り換えを行う様にされていて、

前記、ポート噴射の領域と筒内噴射の領域の境界線がロックアップ付き自動変速機のロックアップ作動領域を規定するのに用いるのと同じ変数によって、ロックアップ作動領域を規定するロックアップ線よりも高負荷側に設定されていることを特徴とする自動車用エンジンの燃料噴射装置。

【請求項３】　運転状態の変化に応じてポート噴射と筒内噴射とを切り換える噴射方法切り換え手段を有した自動車用エンジンの燃料噴射装置であって、

フューエルカット状態を検出するフューエルカット状態検出手段を備え、

フューエルカット時にポート噴射から筒内噴射への切り換えを行う様にしたことを特徴とする自動車用エンジンの燃料噴射装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、燃料噴射装置、特に、ポート噴射と筒内噴射とを切り換える自動車用エンジンの燃料噴射装置に関する。

【０００２】

【従来の技術】筒内噴射とポート噴射の２つの噴射系を有し、負荷、回転数、あるいは、その他の運転条件によって、これらの噴射系を使い分ける様にした自動車用エンジンがすでに公知であり、例えば、軽負荷では筒内噴射のみを用い、中負荷では両者併用し、高負荷ではポート噴射のみを用いるように切り換えたり、あるいは始動

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時にはポート噴射を用い、始動後のある時点において筒内噴射に切り換えるという様な制御が考えられている。ところが、ポート噴射では噴射された燃料の一部が吸気ポートの壁面に付着し、あるタイミングで噴射された燃料の全てが同時にシリンダー内に吸入されないので筒内噴射からポート噴射に切り換えた場合には、一時的に燃料が過少になったり、ポート噴射から筒内噴射に切り換えた場合には、一時的に燃料が過多になったりしてエンジンの発生するトルクに段差が発生し車両乗員に不快なショックを与えることがある。したがって、従来より、車両乗員に不快なショックを与えない様にしようとする提案が数多くなされており、例えば、特開昭６３－１５４８１６号公報では筒内噴射とポート噴射の切り換え時に一定時間だけ筒内噴射とポート噴射の両方を行うことによって、エンジントルクに段差が発生することを防止して車両乗員に不快なショックを与えない様にしている。

【０００３】

【発明が解決しようとする課題】ところが、上記公報の装置を目的通りに正しく作用させるためには、吸気管への燃料の付着量等を推測して燃料噴射量、噴射時期等を制御することが必要であり高い精度の燃料制御が要求され、結果的にコストの増大を招く。ところで、本願の最終目的は車両の乗員に筒内噴射とポート噴射の切り換えに起因するショックが乗員に不快に伝わらない様にすることであって、ショックの発生そのものを防止することは必ずしも必要ではない。本発明は上記問題に鑑み、高い精度の燃料制御性を必要とせずに筒内噴射とポート噴射の切り換え時のショックを車両の乗員に伝えない、あるいはショックの伝達を軽減する様にした燃料噴射装置を提供することを目的とする。

【０００４】

【課題を解決するための手段】本発明の請求項１によれば、運転状態の変化に応じてポート噴射と筒内噴射とを切り換える噴射方法切り換え手段を有したロックアップ付き自動変速機と一緒に用いられる自動車用エンジンの燃料噴射装置において、運転状態が予め定めておいたポート噴射の領域と筒内噴射の領域の境界線を越えて変化したかどうかを判定する運転状態判定手段と、ロックアップ付き自動変速機のロックアップ作動検出手段とを備え、運転状態が予め定めておいたポート噴射の領域と筒内噴射の領域の境界線を越えて変化し、前記ロックアップ作動検出手段がロックアップ作動信号を出力していない場合にのみポート噴射と筒内噴射との切り換えを行う様にした自動車用エンジンの燃料噴射装置が提供される。請求項２によれば、運転状態の変化に応じてポート噴射と筒内噴射とを切り換える噴射方法切り換え手段を有したロックアップ付き自動変速機と一緒に用いられる自動車用エンジンの燃料噴射装置であって、運転状態が予め定めておいたポート噴射の領域と筒内噴射の領域の

入空気量などを検出すればよく、吸気通路の壁温についてはこれを直接検出せず吸気温又は水温などによって代替してもよい。また、前記減量補正手段は、減量補正率を、機関負荷（請求項４）、吸気通路の壁温（請求項５）、直前における補助燃料噴射弁の作動状態の継続時間（請求項６）に応じて設定するとよい。

【０００９】

【発明の効果】本発明（請求項１）によれば、補助燃料噴射弁の非作動状態から作動状態への切換時（ＯＦＦ→ＯＮ時）に、主燃料噴射弁の燃料噴射量を一時的に増量補正することで、壁流付着による空燃比のリーンエラーを防止できる。また、補助燃料噴射弁の作動状態から非作動状態への切換時（ＯＮ→ＯＦＦ時）に、主燃料噴射弁の燃料噴射量を一時的に減量補正することで、壁流吸入による空燃比のリッチエラーを防止できる。

【００１０】また、機関負荷によって壁流量が変わり、高負荷側で壁流量が大となることから、増量補正率及び減少補正率を機関負荷に応じて設定して、高負荷側ほど、増量補正率及び減少補正率を大きくすることで、これらに良好に対応できる（請求項２、請求項４）。また、吸気通路の壁温によって壁流量が変わり、低温側で壁流量が大となることから、増量補正率及び減少補正率を吸気通路の壁温に応じて設定して、低温ほど、増量補正率及び減少補正率を大きくすることで、これらに良好に対応できる（請求項３、請求項５）。

【００１１】更に、補助燃料噴射弁の作動状態の継続時間（ＯＮ域滞在時間）によって壁流量が変わり、この時間が長いと壁流量が大となることから、ＯＮ→ＯＦＦ時の減少補正率をこの時間に応じて設定して、この時間が長いほど、減少補正率を大きくすることで、これに良好に対応できる（請求項６）。

【００１２】

【発明の実施の形態】以下に本発明の実施の形態について説明する。図２は一実施形態を示す内燃機関のシステム図である。先ず、これについて説明する。車両に搭載される内燃機関１の各気筒の燃焼室には、スロットル弁２の制御を受けて、吸気通路（吸気マニホールド）３より、空気が吸入される。

【００１３】そして、各気筒毎に、燃焼室内に燃料（ガソリン）を直接噴射するように、電磁式の主燃料噴射弁４が設けられている。また、全気筒共通に、吸気マニホールド３の集合部（コレクタ）に燃料を噴射して各気筒に分配するように、電磁式の補助燃料噴射弁５が設けられている。尚、この補助燃料噴射弁５は、４気筒の場合、第５弁とも呼ばれる。

【００１４】主燃料噴射弁４は、コントロールユニット６から機関回転に同期して各気筒の吸気行程又は圧縮行程にて出力される噴射パルス信号によりソレノイドに通電されて開弁し、所定の高圧力に調圧された燃料を噴射するようになっている。そして、噴射された燃料は、吸

気行程噴射の場合は燃焼室内に拡散して均質な混合気を形成し、また圧縮行程噴射の場合は点火栓回りに集中的に層状の混合気を形成し、点火栓により点火されて、燃焼（均質燃焼又は成層燃焼）する。

【００１５】補助燃料噴射弁５は、均質燃焼時の特定領域で、又は成層燃焼と均質燃焼との切換えに同期して均質燃焼時に、コントロールユニット６から機関回転に同期して例えば１回転毎に出力される噴射パルス信号によりソレノイドに通電されて開弁し、所定の低圧力に調圧された燃料を噴射するようになっている。そして、噴射された燃料は吸気マニホールド３内である程度均質化して、各気筒へ分配される。

【００１６】尚、主燃料噴射弁４及び補助燃料噴射弁５への燃料供給系は、燃料タンク７内の燃料を吸入吐出する低圧燃料ポンプ８と、低圧燃料ポンプ８の吐出側圧力を調圧する低圧レギュレータ９と、低圧燃料ポンプ８からの燃料を更に加圧する高圧燃料ポンプ１０と、高圧燃料ポンプの吐出側圧力を調圧する高圧レギュレータ１１とを含んで構成され、高圧レギュレータ１１により調圧された高圧燃料を燃料ギャラリ１２を介して主燃料噴射弁４に供給し、低圧レギュレータ９により調圧された低圧燃料を補助燃料噴射弁５に供給するようになっている。

【００１７】コントロールユニット６は、ＣＰＵ、ＲＯＭ、ＲＡＭ、Ａ／Ｄ変換器及び入出力インターフェイス等を含んで構成されるマイクロコンピュータを備え、各種センサからの入力信号を受け、これに基づいて演算処理して、主燃料噴射弁４及び補助燃料噴射弁５などの作動を制御する。前記各種センサについては図示を省略したが、機関１のクランク軸又はカム軸回転を検出し、これにより機関回転数ＮＥを検出可能なクランク角センサ、スロットル弁２上流で吸入空気量ＱＡを検出するエアフローメータ、スロットル弁２の開度ＴＶＯを検出するスロットルセンサ、機関１の冷却水温ＴＷを検出する水温センサ、吸気温ＴＡを検出する吸気温センサなどが設けられている。

【００１８】次に、コントロールユニット６により行われる燃料噴射制御について、図３～図５のフローチャートにより説明する。図３は燃料噴射制御ルーチンであり、所定回転毎、又は所定時間毎に実行される。本ルーチンが切換制御手段に相当する。ステップ１（図にはＳ１と記す。以下同様）では、機関運転条件に基づいて、機関が必要とする１気筒（１燃焼）当たりの燃料噴射量ＱＦを演算する。具体的には、機関運転条件より均質燃焼又は成層燃焼に設定し、吸入空気量ＱＡ及び機関回転数ＮＥに基づいて、目標空燃比（均質燃焼の場合は一般にストイキ、成層燃焼の場合はリーン）となるように要求燃料噴射量ＱＦを演算する。

【００１９】ステップ２では、補助燃料噴射弁の作動域（ＯＮ域）か否かを判定する。ここでは、補助燃料噴射

弁のＯＮ域を均質燃焼時の特定領域（高回転・高負荷域）とする。補助燃料噴射弁のＯＮ域の場合は、ステップ3へ進む。ステップ3では、主燃料噴射弁と補助燃料噴射弁との分担率（補助燃料噴射弁側の分担率）Ｐを設定する。この分担率Ｐは機関負荷によって可変とするとよい。

【００２０】ステップ4では、次式により、要求燃料噴射量ＱＦに分担率Ｐを乗じて、補助燃料噴射弁の燃料噴射量ＱＦ5 を演算する。

ＱＦ5 ＝２×ＱＦ×Ｐ

２倍しているのは、補助燃料噴射弁は１回転に１回噴射、すなわち２気筒分ずつ噴射する設定としているからである。

【００２１】ステップ5では、演算された補助燃料噴射弁の燃料噴射量ＱＦ5 を燃料圧力（低圧レギュレータの設定圧力）を考慮して噴射パルス幅（噴射時間）に変換し、所定のレジスタにセットする。これにより、所定の噴射タイミングになると、この噴射パルス幅の信号で補助燃料噴射弁が駆動されて、吸気マニホールド内に燃料噴射がなされる。

【００２２】ステップ6では、図4のサブルーチンに従って、補正率（増量補正率）ＨＯＳを演算する。これについては後述する。ステップ7では、次式により、要求燃料噴射量ＱＦに主燃料噴射弁側の分担率（１－Ｐ）を乗じて、また補正率ＨＯＳを乗じて、主燃料噴射弁の燃料噴射量ＱＦ1-4 を演算する。

【００２３】ＱＦ1-4 ＝ＱＦ×（１－Ｐ）×ＨＯＳ

そして、ステップ１０へ進む。ステップ１０では、演算された主燃料噴射弁の燃料噴射量ＱＦ1-4 を燃料圧力（高圧レギュレータの設定圧力）を考慮して噴射パルス幅（噴射時間）に変換し、所定のレジスタにセットする。これにより、所定の噴射タイミングになると、この噴射パルス幅の信号で主燃料噴射弁が駆動されて、燃焼室内に直接燃料噴射がなされる。

【００２４】補助燃料噴射弁のＯＦＦ域の場合は、ステップ８へ進む。この場合は主燃料噴射弁のみで燃料噴射を行う。ステップ８では、図５のサブルーチンに従って、補正率（減量補正率）ＨＯＳを演算する。これについては後述する。ステップ９では、次式により、要求燃料噴射量ＱＦに補正率ＨＯＳを乗じて、主燃料噴射弁の燃料噴射量ＱＦ1-4 を演算する。

【００２５】ＱＦ1-4 ＝ＱＦ×ＨＯＳ

そして、ステップ１０へ進む。ステップ１０では、前述のように、演算された主燃料噴射弁の燃料噴射量ＱＦ1-4 を燃料圧力を考慮して噴射パルス幅に変換し、所定のレジスタにセットする。これにより、所定の噴射タイミングになると、この噴射パルス幅の信号で主燃料噴射弁が駆動されて、燃焼室内に直接燃料噴射がなされる。

【００２６】図４の補正率（増量補正率）演算サブルーチンについて説明する。本サブルーチンが増量補正手段に相当する。ステップ４１では、補助燃料噴射弁のＯＦＦ→ＯＮの初回か否かを判定する。初回の場合は、ステップ４２へ進み、機関負荷（吸入空気量ＱＡ）、吸気温ＴＡに応じて、補正率（増量補正率）ＨＯＳを設定して（ＨＯＳ＞１．０）、本サブルーチンを終了する。ここで、機関負荷が大きい程、また吸気温が低い程、補正率（増量補正率）ＨＯＳを大きく設定する。

【００２７】初回以降は、ステップ４３へ進み、補正率（増量補正率）ＨＯＳを漸減する（ＨＯＳ＝ＨＯＳ－ΔＨＯＳ；ΔＨＯＳは所定の微小値）。そして、ステップ４４で、補正率（増量補正率）ＨＯＳが１．０より小さくなったか否かを判定し、ＨＯＳ＜１．０の場合は、ステップ４５で、ＨＯＳ＝１．０に規制する。

【００２８】このような制御により、補助燃料噴射弁のＯＦＦ→ＯＮ時に、図６に示すように、主燃料噴射弁の燃料噴射量を補助燃料噴射弁の分担分減少させる際に、一時的に主燃料噴射弁の燃料噴射量を増量補正することで、補助燃料噴射弁から噴射された燃料の一部が吸気通路壁に付着して壁流となって、燃料の輸送遅れを生じても、主燃料噴射弁の燃料噴射量の増量補正により、空燃比のリーンエラーを防止できる。

【００２９】図５の補正率（減量補正率）演算サブルーチンについて説明する。本サブルーチンが減量補正手段に相当する。ステップ５１では、補助燃料噴射弁のＯＮ→ＯＦＦの初回か否かを判定する。初回の場合は、ステップ５２へ進み、機関負荷（吸入空気量ＱＡ）、吸気温ＴＡ、ＯＮ域滞在時間に応じて、補正率（減量補正率）ＨＯＳを設定して（ＨＯＳ＜１．０）、本サブルーチンを終了する。ここで、機関負荷が大きい程、また吸気温が低い程、更にＯＮ域滞在時間が長い程、補正率（減量補正率）ＨＯＳを大きく（１．０よりより小さく）設定する。

【００３０】初回以降は、ステップ５３へ進み、補正率（減量補正率）ＨＯＳを漸増する（ＨＯＳ＝ＨＯＳ＋ΔＨＯＳ；ΔＨＯＳは所定の微小値）。そして、ステップ５４で、補正率（減量補正率）ＨＯＳが１．０より大きくなったか否かを判定し、ＨＯＳ＞１．０の場合は、ステップ５５で、ＨＯＳ＝１．０に規制する。

【００３１】このような制御により、補助燃料噴射弁のＯＦＦ→ＯＮ時に、図６に示すように、主燃料噴射弁の燃料噴射量を補助燃料噴射弁の分担分増大させる際に、一時的に主燃料噴射弁の燃料噴射量を減量補正することで、壁流分が吸入されても、主燃料噴射弁の燃料噴射量の減量補正により、空燃比のリッチエラーを防止できる。

【００３２】尚、図６ではＯＦＦ→ＯＮ時の初回の増量補正により主燃料噴射弁の燃料噴射量が切換前（ＯＦＦ時）の燃料噴射量より大きくなっており、また、ＯＮ→ＯＦＦ時の初回の減量補正により主燃料噴射弁の燃料噴射量が切換前（ＯＮ時）の燃料噴射量より小さくなって

いるが、これに限るものではなく、切換後の目標燃料噴射量に対し増量補正又は減量補正がなされていればよい。

【００３３】次に、本発明の他の実施形態について説明する。この実施形態は、均質燃焼（均質ストイキ燃焼）と成層燃焼（成層リーン燃焼）との切換えに同期して、均質燃焼時に補助燃料噴射弁を作動させて、機関への燃料供給を主燃料噴射弁と補助燃料噴射弁とに分担させる場合に適用したものである。

【００３４】図７は燃料噴射制御ルーチンであり、所定回転毎、又は所定時間毎に実行される。ステップ１１では、機関運転条件に基づいて、均質燃焼か成層燃焼かを判定する。均質燃焼の場合は、ステップ１２へ進む。

【００３５】ステップ１２では、均質燃焼の場合の機関が必要とする１気筒（１燃焼）当たりの燃料噴射量ＱＦＨを演算する。具体的には、吸入空気量ＱＡ及び機関回転数ＮＥに基づいて、目標空燃比（一般にストイキ）となるように要求燃料噴射量ＱＦＨを演算する。そして、均質燃焼の場合は、補助燃料噴射弁のＯＮ域であるので、ステップ１２の後、ステップ１３～１７、２１で、図３のステップ３～７、１０と同様に制御する。異なる点は、ステップ１４及びステップ１７の演算式で、要求燃料噴射量として、ＱＦに代えて、ＱＦＨを用いている点である。

【００３６】成層燃焼の場合は、ステップ１８へ進む。ステップ１８では、成層燃焼の場合の機関が必要とする１気筒（１燃焼）当たりの燃料噴射量ＱＦＳを演算する。具体的には、吸入空気量ＱＡ及び機関回転数ＮＥに基づいて、目標空燃比（リーン）となるように要求燃料噴射量ＱＦＳを演算する。

【００３７】そして、成層燃焼の場合は、補助燃料噴射弁のＯＦＦ域であるので、ステップ１８の後、ステップ１９～２１で、図３のステップ８～１０と同様に制御する。異なる点は、ステップ２０の演算式で、要求燃料噴射量として、ＱＦに代えて、ＱＦＳを用いている点である。もちろん、ステップ１６及びステップ１９では、図４及び図５のサブルーチンに従って、補正率（増量補正率及び減量補正率）ＨＯＳの演算が行われる。

【００３８】このような制御により、成層燃焼→均質燃焼への切換時（補助燃料噴射弁のＯＦＦ→ＯＮ時）に、図８に示すように、主燃料噴射弁の燃料噴射量を補助燃料噴射弁の分担分減少させ、同時にリーン→ストイキ化のため増大させる際に、一時的に主燃料噴射弁の燃料噴射量を増量補正することで、補助燃料噴射弁から噴射された燃料の一部が吸気通路壁に付着して壁流となって、燃料の輸送遅れを生じても、主燃料噴射弁の燃料噴射量の増量補正により、空燃比のリーンエラーを防止できる。

【００３９】また、均質燃焼→成層燃焼への切換時（補助燃料噴射弁のＯＦＦ→ＯＮ時）に、図８に示すように、主燃料噴射弁の燃料噴射量を補助燃料噴射弁の分担分増大させ、同時にストイキ→リーン化のため減少させる際に、一時的に主燃料噴射弁の燃料噴射量を減量補正することで、壁流分が吸入されても、主燃料噴射弁の燃料噴射量の減量補正により、空燃比のリッチエラーを防止できる。

【図面の簡単な説明】

【図１】　本発明の構成を示す機能ブロック図

【図２】　本発明の一実施形態を示す内燃機関のシステム図

【図３】　燃料噴射制御ルーチンのフローチャート

【図４】　増量補正率演算サブルーチンのフローチャート

【図５】　減量補正率演算サブルーチンのフローチャート

【図６】　補助燃料噴射弁のＯＮ／ＯＦＦ切換時の特性図

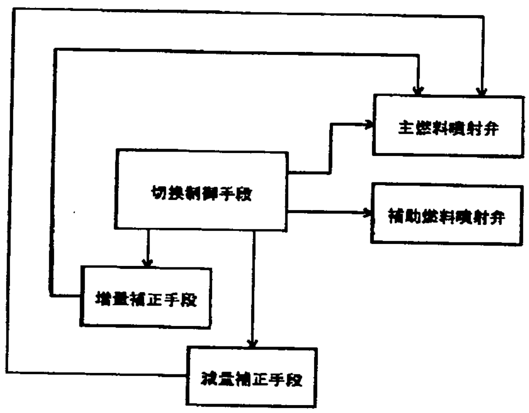
【図７】　他の実施形態を示す燃料噴射制御ルーチンのフローチャート

【図８】　均質燃焼／成層燃焼切換時の特性図

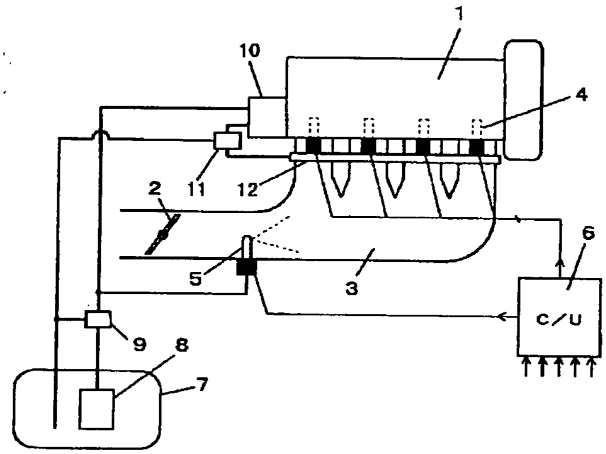
【符号の説明】

1　内燃機関
2　スロットル弁
3　吸気マニホールド
4　主燃料噴射弁
5　補助燃料噴射弁
6　コントロールユニット
7　燃料タンク
8　低圧燃料ポンプ
9　低圧レギュレータ
１０　高圧燃料ポンプ
１１　高圧レギュレータ
１２　燃料ギャラリ

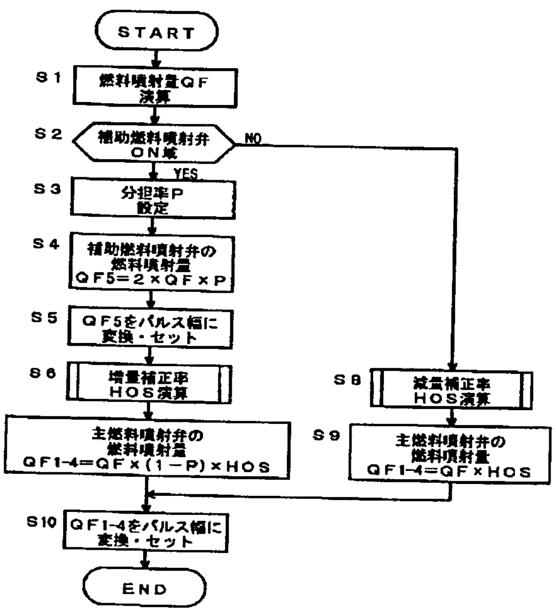
【図1】



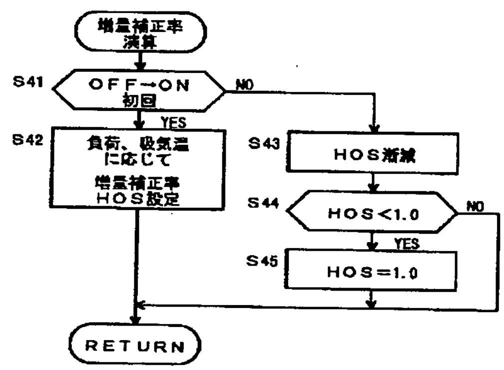
【図2】



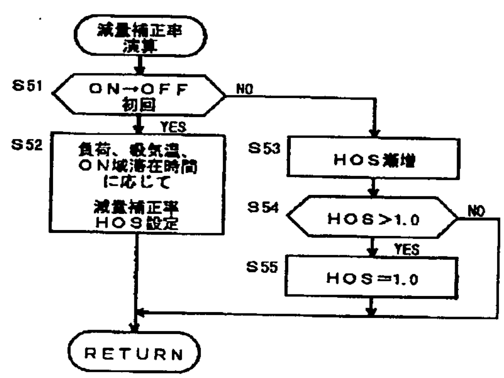
【図3】



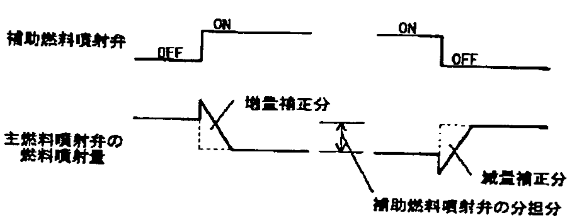
【図4】



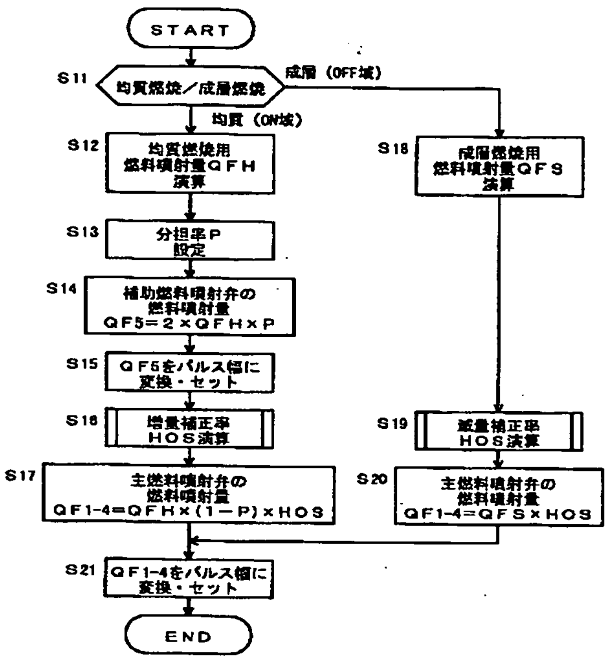
【図5】



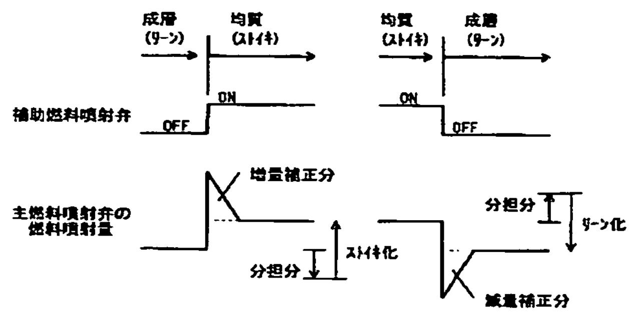
【図6】



【図7】


START
S11
均質燃焼／成層燃焼
成層（OFF域）
均質（ON域）
S12
均質燃焼用燃料噴射量QFH演算
S13
分担率P設定
S14
補助燃料噴射弁の燃料噴射量QF5＝2×QFH×P
S15
QF5をパルス幅に変換・セット
S16
増量補正率HOS演算
S17
主燃料噴射弁の燃料噴射量QF1-4＝QFH×(1－P)×HOS
S18
成層燃焼用燃料噴射量QFS演算
S19
減量補正率HOS演算
S20
主燃料噴射弁の燃料噴射量QF1-4＝QFS×HOS
S21
QF1-4をパルス幅に変換・セット
END

【図8】


成層(リーン)
均質(ストイキ)
均質(ストイキ)
成層(リーン)
補助燃料噴射弁
ON
OFF
ON
OFF
主燃料噴射弁の燃料噴射量
増量補正分
分担分
ストイキ化
分担分
リーン化
減量補正分